Early exposures to ecogenomics

Bos, M.J.W.; Koolstra, C.M.; Willems, J.T.J.M.

published in
Science Communication
2010

DOI (link to publisher)
10.1177/1075547009358625

10.1177/1075547009358625

Science Communication
http://scx.sagepub.com/

Early Exposures to Ecogenomics: Effects of Priming and Web Site Interactivity Among Adolescents

Mark J. W. Bos, Cees M. Koolstra and Jaap T. J. M. Willems

Science Communication 2010 32: 232
DOI: 10.1177/1075547009358625

The online version of this article can be found at:
http://scx.sagepub.com/content/32/2/232

Published by:
SAGE
http://www.sagepublications.com

Science Communication
32(2) 232–255

DOI: 10.1177/1075547009358625
http://scx.sagepub.com

Early Exposures to Ecogenomics: Effects of Priming and Web Site Interactivity Among Adolescents

Mark J.W. Bos,[1] Cees M. Koolstra,[1] and Jaap T. J. M. Willems[2]

Abstract

In the context of public introductions to emerging technologies, this study examined effects of priming and Web site interactivity on adolescents' attitude development and information processing. In a four (priming) by three (interactivity levels) experiment, participants (N = 273) were required to search for and process Web-based information about ecogenomics. Results showed that priming ecogenomics as biotechnology, ecology, economy, or science in general did not affect attitude development. Interactivity levels, manipulated as low, medium, and high, were found to influence adolescents' time invested in the information-processing task, perceived cognitive load, and Web site evaluations.

Keywords

priming, Web site interactivity, perceived cognitive load, attitude development, knowledge acquisition, ecogenomics

[1]VU University, Amsterdam, Netherlands
[2]University of Twente, Enschede, Netherlands

Corresponding Author:
Mark J.W. Bos, Department of Science Communication, Faculty of Earth and Life Sciences, VU University, De Boelelaan 1085, 1081 HV Amsterdam, Netherlands
Email: mark.bos@falw.vu.nl

In recent years, the public has been confronted with many new developments in science and technology, such as biotechnology, stem cell research, cloning, and nanotechnology (e.g., Nisbet, 2004; Scheufele & Lewenstein, 2005; Shanahan, Scheufele, & Lee, 2001; Wynne, 2005). Genomics is another such example. Genomics studies the function and interactions of all genes in an organism's genome, all of the genetic material in a cell or organism. A spin-off of this type of research is ecogenomics. Ecogenomics makes use of genomics-like techniques to study ecosystems at their genetic level. An important benefit of this technology is that new methods have made it possible to analyze organisms that could neither be cultured nor studied using traditional methods. Uncovering the "ecogenome" may prove a rich source for the discovery of new products, such as antibiotics, antitumor-, cholesterol-lowering-, and antiparasitic agents, but also bioinsecticides, laundry detergents, and biofuels (see, e.g., Daniel, 2004; Demain & Adrio, 2008; Langer et al., 2006; Lefevre et al., 2008; Petit, 2004; Riesenfeld, Goodman, & Handelsman, 2004). As such, ecogenomics may be expected to have an important impact on the scientific, economical, and social domains (e.g., Roelofsen, Broerse, De Cock Buning, & Bunders, 2008).

Ecogenomics has not yet made frequent appearances in public media, and because most people are still unfamiliar with this topic, the present study used ecogenomics to study its first introduction into the public arena. Whereas most of the earlier studies on first introductions of new technologies have used surveys (e.g., Cobb & Macoubrie, 2004; Lee, Scheufele, & Lewenstein, 2005; Priest, 2006; Scheufele & Lewenstein, 2005; Shanahan et al., 2001) with the limitation that causal conclusions are difficult to draw, there are also some recent studies that have used an experimental design. For example, both Cobb (2005) and Schütz and Wiedemann (2008) investigated framing effects in the context of developing public opinions about nanotechnology. The big advantage of using an experimental design in this context is that researchers can select and manipulate factors that are considered to be influential and that results can be interpreted in causal terms.

The present study also used an experimental design offering the possibility of drawing causal conclusions. Of additional value to this study is that the introduction of ecogenomics as an emerging technology is studied in a very early stage in which not many people have heard about the technology. This makes it possible to study public perceptions that are not yet affected by possible prejudices or predispositions as a result of previous media exposure. The two factors studied here are priming and Web site interactivity. Priming was studied to recognize that during introductions of emerging technologies this new information will be linked to existing information most readily available from (implicit) memory: People will use existing knowledge and attitudes about scientific developments, activated as a result of stimuli, to form opinions about new technologies. Web site interactivity was studied to acknowledge that most introductions of new technologies are media dependent. As the Internet is quickly becoming a preferred medium to acquire and process information among users, the information about ecogenomics was presented to participants through Web sites that were manipulated to vary in interactivity. In our experiment, participants received instructions to acquire as much information about the new technology as they could, after which they would receive some questions about ecogenomics. After completion of this information-processing task, participants had to fill in an online survey measuring five dependent measures (including the questions that measured knowledge acquisition with respect to ecogenomics). The dependent variables investigated in the present study were attitude development as a result of different types of priming, and various aspects of information processing (time invested in the task, perceived cognitive load, knowledge acquisition, and Web site evaluation) as results of different levels of Web site interactivity.

Effects of Priming

Various communication theories explain the relation between media exposure and developing public opinion toward science issues. Especially, research on agenda setting has focused on how media attention for particular issues affects the salience of these issues among the public. Agenda setting and priming are based on the assumption that media attention for a particular issue affects the salience of that issue and thereby the manner in which people evaluate it (e.g., Kiousis & McCombs, 2004; Scheufele, 2000). In this context, the concept of priming revolves around the idea that stimuli can activate existing cognitions and will thereby influence information behaviors and attitudes (Brewer, Graf, & Willnat, 2003; referring also to Fiske & Taylor, 1984). The theory poses that those issues most readily available in memory will most strongly influence the manner in which the new information is processed and evaluated.

In the case of science issues, people may not be expected to initiate extensive information-processing behaviors, especially when the subject is perceived to have low personal relevance, in which case they are most likely to use information readily available to them from memory about seemingly related subjects (see among others, Cobb & Macoubrie, 2004; Eagly & Chaiken, 1993; Fiske & Taylor, 1984; Lee et al., 2005; Petty & Cacioppo, 1986; Scheufele & Lewenstein, 2005). In this light, a person's opinion about an emerging technology may be based on opinions about science issues that he or she thinks are related to the newly introduced subject or technology. Priming a new technology may activate particular existing cognitions and influence information behaviors and attitude formation accordingly. Based on premises from the cognitive dissonance theory (Festinger, 1957) and elaboration likelihood model (Petty & Cacioppo, 1986), which describe how people prefer to expose themselves to information that confirms existing ideas of and opinions about issues at hand and that new information is processed and interpreted based on those predispositions, Bonfadelli, Dahinden, and Leonarz (2002) propose that media attention may be expected to strengthen rather than change attitudes.

However, Bonfadelli et al. (2002) also indicated that issues about which people do not yet hold firmly established predispositions may be exceptions to that rule, such as biotechnology in their study and ecogenomics in this one. Because ecogenomics is a subject about which the general public may be expected to know little or nothing (see also Bos, Koolstra, & Willems, 2009), the context in which it is introduced to the public may be expected to have a profound effect on the development of opinions. Whereas experts position ecogenomics at the crossroads of research areas such as molecular biology, biotechnology, ecology, soil and environmental sciences, this context may be unknown for the public. This makes ecogenomics an interesting subject of study, because it may be expected that people will evaluate information about ecogenomics differently depending not only on the context within which it is introduced but also on existing cognitions and opinions that become activated after such early exposures to new information.

The present study preferred the concept of priming over that of framing, because in our experimental design we aimed to influence "what" the public is thinking when confronted with ecogenomics—so as to activate existing cognitions and attitudes—rather than "how" the public would come to think of ecogenomics (for discussions about framing and priming, see also Boyle et al., 2006; Scheufele & Tewksbury, 2007). Note also that, at the time of the present study, ecogenomics had not yet made frequent appearances in the public media and therefore frames for ecogenomics were nonexistent. The study investigated the extent to which participants' developing attitudes toward ecogenomics were influenced by a negative or positive context within which it was introduced. For this purpose, ecogenomics was introduced to participants as either biotechnology, with the assumption that negative associations would be made, or ecology, with the assumption that positive associations would be made. These assumptions were based on previous studies and related measurements of public attitudes toward biotechnology and ecology. Biotechnology has been shown to be a controversial issue that has been met with opposition among the European public, especially biotechnology aimed at genetic modifications of organisms and in the contexts of agricultural biotechnology (see, e.g., Bucchi & Neresini, 2002; European Commission, 2006; Gaskell et al., 2000). On the other hand, ecology may be expected to activate positive associations based on findings that Europeans hold environment-friendly attitudes in general (European Commission, 2008) and specifically toward species conservation and ecosystem management (Jacobson & Marynowski, 1997). Additionally, in other conditions ecogenomics was introduced as science in general or as economy. The science-in-general label was selected with the idea that this concept is so broadly defined and covering all disciplines (with possible positive and negative associations) that it may be considered as neutral (or control condition). The economy label was added to increase ecological validity, because an earlier study using open-ended questions had shown that spontaneous associations of adolescents with ecogenomics pertained more frequently to economy than to ecology or biotechnology (Bos et al., 2009). The priming hypothesis was stated as follows:

> *Hypothesis 1:* Priming ecogenomics will influence attitude development in such a manner that introducing it as biotechnology will result in more negative attitudes and introducing it as ecology will result in more positive attitudes toward ecogenomics as compared with introducing it as either science in general or economy.

Effects of Web Site Interactivity

Apart from effects due to media attention and content, the media format in which new information is presented may also influence information-processing behaviors. With the introduction of the Internet, people have gained access to yet another medium through which they are, or may choose to be, exposed to science information. In this context, the concept of interactivity has sparked the interest of many researchers in the field of science communication. Since the 1980s, interactivity has received increasing amounts of attention in science literature (e.g., Kiousis, 2002; Koolstra & Bos, 2009; McMillan, 2002). In some publications, the concept is described as a new and superior mode of communication, as compared with more traditional transmission modes (e.g., Cocheret de la Monière, 2006; Van Woerkum & Van der Auweraert, 2004). However, research on actual effectiveness of interactivity in various contexts is ongoing (e.g., Beetlestone, Johnson, Quin, &White, 1998; Rowe, Horlick-Jones, Walls, & Pidgeon, 2005; Tremayne & Dunwoody, 2001).

Interactivity and the Internet seem to be closely related. Quite a few publications about interactive communication are concerned with the Internet as a medium, most specifically with Web sites. Some authors have indicated that interactivity is an intricate element of Web sites (e.g., Sundar, Kalyanaraman, & Brown, 2003), whereas others have indicated that most Web sites, especially science Web sites, may be characterized by their linear noninteractive modes of communication (e.g., Miller, 2001). In the context of interactivity and science Web sites, various authors have looked at how interactivity influences the communication processes. Weigold and Treise (2004), for example, explored how interactivity may be used to attract audiences for science Web sites. Tremayne and Dunwoody (2001) investigated relations between interactivity and cognitive elaboration and learning. And Macedo-Rouet, Rouet, Epstein, & Fayard (2003) looked at differences in users' comprehension and appreciation of information published online as compared with that in print.

While some authors have expressed that increased interactivity will have positive influences on communication outcomes, for example, on levels of motivation, sense of fun, cognition, learning, openness, frankness, and sociability (Rafaeli, 1988; Rafaeli & Sudweeks, 1997), others have expressed more neutral, or even negative, opinions. Burgoon et al. (2002), as well as Liu and Shrum (2002), for example, suggested that interactivity should not be viewed as inherently positive. On a similar note, Vorderer, Knobloch, and Schramm (2001) indicated that too much interactivity may inhibit rather than enhance certain aspects of communication processes. Some examples of possible disadvantages of Web site interactivity are that people may be lacking skills necessary to make efficient use of the Internet to search for and process new information (e.g., Metzger, Flanagin, & Zwarun, 2003; Nahl & Harada, 2004; Whitmire, 2004; Wu & Tsai, 2005). In turn, the skills and actions necessary to access and process information derived from the Internet may increase cognitive load (e.g., Eveland & Dunwoody, 2001; Kim & Hirtle, 1995).

The present study approached interactivity from a functional perspective (see McMillan & Hwang, 2002) and used Jensen's (1998) definition of interactivity as "a media's potential ability to let the user exert an influence on the content and/or form of the mediated communication" (p. 201). The concept was operationalized similar to the approach of Sundar et al. (2003): the level of Web site interactivity was increased by increasing the number of technological and or structural features that users could employ while navigating (e.g., hyperlinks, e-mail, and FAQs).

We tested four hypotheses concerning the relation between Web site interactivity levels and information-processing behaviors. Based on negative connotations about possible effects of interactivity (e.g., Eveland & Dunwoody, 2001; Kim & Hirtle, 1995; Macedo-Rouet et al., 2003; Metzger et al., 2003; Nahl & Harada, 2004; Vorderer et al., 2001; Whitmire, 2004; Wu & Tsai, 2005), we predicted that higher levels of Web site interactivity would lead to more time invested in the information-processing task and to perceptions of higher cognitive load during the task:

Hypothesis 2: Web site interactivity will influence users' information-processing behaviors in such a manner that higher levels of interactivity will increase the time users spend on a Web site in search of information about ecogenomics.

Hypothesis 3: Web site interactivity will influence users' information processing in such a manner that higher levels of interactivity will increase the level of perceived cognitive load among users.

Based on the positive connotations about possible effects of interactivity (Cocheret de la Monière, 2006; MacGregor & Lou, 2004; Rafaeli, 1988; Rafaeli & Sudweeks, 1997; Tremayne & Dunwoody, 2001; Van Woerkum & Van der Auweraert, 2004), we predicted that higher levels of Web site interactivity would increase the level of knowledge acquisition and would have a beneficial effect on Web site evaluations after completion of the task:

Hypothesis 4: Web site interactivity will influence users' information processing in such a manner that higher levels of interactivity will lead to higher scores on measures of knowledge acquisition about ecogenomics.

Hypothesis 5: Web site interactivity will influence users' information processing in such a manner that higher levels of interactivity will lead to more positive scores on measures of Web site evaluation.

Method

Design, Sample, and Procedure

The four (priming) by three (Web site interactivity) experiment was embedded in an online environment. Priming was manipulated by presenting one of the four "contexts," biotechnology, ecology, economy, or science (in general), as a heading text label for each of the Web site pages, and as text in the introductory information about ecogenomics (e.g., "Welcome to Ecogenomics; This Web site provides information about a new development in [biotechnology]"). A manipulation check using four questions about possible associations with each of the contexts to ecogenomics (providing five answering possibilities varying from "very much" to "very little") showed that this manipulation was effective ($F = 9.13$; $p < .01$). Web site interactivity was manipulated by designating participants to one of three separate Web site environments in which they were required to perform the information-processing task. The low-interactivity condition presented a simple eight-page Web site with information about ecogenomics that had no interactive possibilities other than navigational features. The medium-interactivity condition used the same Web site, but provided additional interactive possibilities: (a) hyperlinks to emphasize specific words and to redirect readers to extra pages that contained information about that topic, (b) a "Frequently Asked Questions" Web page, (c) to send an e-mail to ecogenomics experts, and (d) to enroll for a newsletter about ecogenomics. The high-interactivity condition presented the task in a similar manner, but after the introduction these participants were requested to search on the World Wide Web for information about ecogenomics. The assumption was that this condition was the most interactive one, because this condition allowed participants the freedom to interact with multiple Web sites (e.g., access Web sites by using links presented on visited Web sites) and use e-mail and other interactive features hosted by visited Web sites. A manipulation check using three questions based on a study conducted by Kalyanaraman and Sundar (2006; "The structure of the website[s] was interactive," "The content of the website[s] was interactive," and "It is easy to communicate with other people through this [these] website[s]") on a 5-point scale (ranging from *totally disagree* to *totally agree*) showed that this manipulation was also effective ($F = 4.65$; $p = .01$) indicating increases in the perceived Web site interactivity consistent with the three types of Web site environments.

Adolescents were chosen as a target audience because they are continuously exposed to new information, both in and out of school. Also, they are familiar with using the Internet. Finally, it may be expected that adolescents have less definitively established predispositions or prejudices toward (new) scientific issues as compared with adults. Potential participants were recruited from a representative youth panel established by a commercial research institute and offered small incentives in exchange for participation. All participants ($N = 273$) were Dutch, aged between 13 and 19 years ($M = 16.5$; $SD = 1.0$), and enrolled in schools on preuniversity level (VWO). The sample contained more female (66.7%) than male participants.

Participants received invitations to participate through e-mail and were given unique login codes to access the online environments and were randomly distributed across the 12 conditions. Participants received instructions within their designated online environments and, after completion of the information-processing task, the data were collected through an online survey. Participants were in their own home, using their own computer, when they received the invitation and instructions, as well as when they performed the information-processing task.

Measures

Attitude toward ecogenomics. The instrument to measure the attitude toward ecogenomics was based on a measure used by Orbell and Hagger (2006) and consisted of eight semantic-differential items using a 6-point scale. Two examples are, Do you think working with ecogenomics is "wise/foolish" and "good/evil." Reliability of the measure was good (Cronbach's $\alpha = .91$). On average, participants were more positive than negative toward ecogenomics ($M = 32.7$; $SD = 6.9$; with a minimum score of 8 and a maximum of 48; see the appendix for a full list of the survey questions).

Time invested in the task. For each of the participants the time invested in the information-processing task was measured unobtrusively by recording online how much time passed between starting up the introductory Web site and beginning with the survey. Mean invested time in the task was 51.8 minutes ($SD = 42.3$) with a minimum of 1.3 minutes and a maximum of 120 minutes.

Perceived cognitive load. Participants were asked to indicate the extent to which they had perceived a high or low cognitive load while searching and processing information about ecogenomics. The instrument was based on the four-item instrument used by Eveland and Dunwoody (2001) to which four items were added. Answers could be given on a 5-point scale varying from *very true* to *not true at all*. Two example items are, "The information about ecogenomics was so unclear that I found it difficult to understand" and "While reading about ecogenomics I immediately understood what it was about." Reliability of the instrument was adequate (Cronbach's $\alpha = .86$). On average, participants had experienced neither a particularly high or low cognitive load ($M = 20.5$; $SD = 5.9$; with a minimum score of 8 and a maximum of 40).

Knowledge acquisition. The amount of knowledge acquired by participants was measured indirectly by presenting 11 factual statements about content that could be retrieved from different sections of the experimental Web sites for the low and medium Web site interactivity conditions and the World Wide Web for the high Web site interactivity condition. The statements were formulated so as to capture the multidimensional character of ecogenomics. The 11 statements were "Ecogenomics is research on genes," "Organisms of the same species always have the same gene expression," "Mutations change an organism's DNA," "Ecogenomics looks at one gene at a time," "Ecosystems are determined by climate and soil," "All of an organism's DNA codes for genes," "Genes can never transfer between bacteria without human interference," "Every living organism has a genome," "Bacteria are so small they are insignificant for ecosystems," "Plants partially have the same genes as humans," and "The genome is all the genetic material of an organism." Participants were asked to indicate whether they thought the statements were "true" or "false." Answers were coded so that good answers could be summed and a higher score would indicate a higher level of knowledge acquisition. If unidimensionality would have been a criterion, the reliability of this instrument determined with Cronbach's alpha was low (.31), indicating that intercorrelations between the answers were low. We however assumed multidimensionality acknowledging that high intercorrelations were not necessary for the application of this particular measure.[1] The mean number of questions answered correctly was 7.8 (SD = 1.7; with a minimum score of 1 and a maximum of 11).

Web site evaluation. Participants were asked to evaluate the Web sites they had used during the information-processing task. The instrument was based on Web site evaluation-type instruments developed by Kalyanaraman and Sundar (2006), McMillan and Hwang (2002), Sundar and Kalyanaraman (2004), and Wu (1999). It consisted of 10 items, each measured on a 9-point scale varying from *not true at all* to *very true*. Examples of the statements are, "The website[s] seemed very useful," "The information on the website[s] was interesting," and "The website is a good example of a website I would add to my favorites." After recoding the negatively phrased statements so that a high combined score would indicate a positive evaluation of the Web site, reliability for the instrument was adequate (Cronbach's α = .86). On average, participants evaluated visited Web sites neither particularly positive nor negative (M = 44.6; SD = 12.2; with a minimum score of 10 and a maximum of 87).

Analysis

Based on suggestions developed by Cohen (1992) and O'Keefe (2007), it was checked whether the design of the present study would be powerful enough to detect statistically significant differences between groups that could be attributed to differences in the population. With the assumption that a power indicator of .80 would be sufficient to detect medium-sized differences with α = .05, a three- and four-group analysis of variance (ANOVA) would require, respectively, 52 and 45 cases in each group (Cohen, 1992, p. 158). As the present study included Ns of >60 in each group, the risks for making Type I and II errors were very low.

Table 1. Analysis of Variance Outcomes for the Interactivity Hypotheses (Hypothesis 2-Hypothesis 5), Including Mean Scores (and Standard Deviations), for the Dependent Variables

	Mean (*SD*)			
Level of Web Site Interactivity	Hypothesis 2: Invested Time	Hypothesis 3: Perceived Cognitive Load	Hypothesis 4: Knowledge Acquisition	Hypothesis 5: Web Site Evaluation
Low	38.91 (37.69)	19.34 (5.67)	7.95 (1.74)	46.90 (8.78)
Medium	33.91 (37.73)	19.20 (5.67)	7.70 (1.89)	46.51 (12.50)
High	78.64 (38.39)	22.62 (5.77)	7.80 (1.31)	41.01 (13.79)
	F (Partial η^2)			
	38.99 (.23)	10.78 (.08)	2.41 (.05)	6.99 (.05)

Results

Each of the hypotheses was tested using a complete three (interactivity) by four (priming) ANOVA so that unpredicted effects of the factors interactivity and priming could also be investigated.

Hypothesis 1 predicted that priming would influence participants' attitudes toward ecogenomics in such a manner that introducing it as being "biotechnology" would result in more negative attitudes than introducing it as "science in general" or "economy," whereas introducing it as "ecology" would result in more positive attitudes toward ecogenomics. There was no main effect of priming on the attitude toward ecogenomics ($F = 0.63$; $p > .05$). Mean attitude scores in conditions of biotechnology ($M = 32.83$), ecology ($M = 31.76$), economy ($M = 32.81$), and science in general ($M = 33.36$) did not differ significantly, and therefore the hypothesis was not supported. There was also no main effect of interactivity level on attitude formation ($F = 0.54$; $p > .05$; low $M = 32.09$, medium $M = 33.17$, and high $M = 32.84$).

Hypothesis 2 predicted that higher levels of interactivity would increase the time invested by participants in the information-processing task. The results of the ANOVA showed a statistically significant main effect of Web site interactivity on the time participants invested in the information-processing task ($F = 38.99$; $p < .01$; see also Table 1). Post hoc comparisons, using Scheffe tests, indicated that the time invested in the high-interactivity condition ($M = 78.64$) was indeed significantly higher than in the low ($M = 38.91$) and medium conditions ($M = 33.91$; $p < .01$), but that the difference between the low and medium condition was not significant. Hypothesis 2 therefore, received partial support. There was no main effect of priming on invested time in the task ($F = 2.20$; $p > .05$).

Hypothesis 3 predicted that higher levels of interactivity would increase the cognitive load perceived by participants. This hypothesis was also partially supported as the analysis showed a significant main effect for Web site interactivity on perceived cognitive load ($F = 10.78$; $p < .01$). Post hoc Scheffe tests indicated that the perceived cognitive load was higher for participants in the highly interactive condition ($M = 22.62$), as compared with participants in the low ($M = 19.34$) and medium conditions ($M = 19.20$). The difference between the low and medium condition was not significant. There was no main effect of priming on perceived cognitive load ($F = 0.45$; $p > .05$).

Hypothesis 4 predicted that higher levels of interactivity would lead to higher levels of knowledge acquisition among participants. There were no main effects of interactivity level or priming, but there was a statistically significant interaction effect between the two variables ($F = 2.41$; $p < .05$). Post hoc Scheffe tests showed that in the "economy" condition, knowledge acquisition was higher for participants in the low-interactivity condition ($M = 8.10$) than for those in the medium ($M = 6.83$) and high conditions ($M = 7.87$). Hypothesis 4 was therefore not supported, but the interaction effect suggested that (in the economy condition) lower interactivity resulted in more knowledge acquisition.

Finally, Hypothesis 5 predicted that higher levels of interactivity would increase users' appreciation for Web sites. The analysis showed a significant main effect for Web site interactivity on Web site evaluation ($F = 6.99$; $p < .01$), but the post hoc Scheffe tests indicated that, contrary to what was expected, the evaluation of the Web sites was lower for participants in the high-interactivity condition ($M = 41.01$) than for participants in the low ($M = 46.90$) and medium conditions ($M = 46.51$). Therefore, Hypothesis 5 was not supported. There was no main effect of priming on Web site evaluation ($F = .39$; $p > .05$).

Additional analyses were performed to check whether the outcomes of the five ANOVAs described above would differ when gender was included as an extra independent factor, and whether the five dependent variables were correlated. First, including gender affected only the outcome of Hypothesis 3 (with regard to the perceived cognitive load). A marginally significant interaction effect of interactivity level and gender ($F = 2.97$; $p = .053$) showed that this hypothesis seemed to be valid only for female participants: whereas male participants did not differ in their perceived cognitive load, the cognitive load was significantly ($p < .01$) higher for female participants

Table 2. Correlations Between the Five Dependent Variables

	1	2	3	4	5
1. Invested time	—				
2. Perceived cognitive load	.06	—			
3. Knowledge acquisition	.27*	−.27*	—		
4. Web site evaluation	−.16*	−.32*	.01	—	
5. Attitude toward ecogenomics	.24*	−.41*	.16*	.29*	—

*$p < .01$.

in the high-interactivity condition (M = 23.19), as compared with the medium (M = 18.74) and low conditions (M = 18.46). Separate additional main effects for gender indicated that female participants scored higher than males on the attitude toward ecogenomics (Hypothesis 1: M = 33.49 vs. M = 30.87; F = 8.07; $p < .01$), and that females invested marginally more time in the task than males (Hypothesis 2: M = 53.50 vs. M = 43.78; F = 3.69; p = .056). Main or interaction effects for gender were not found in the analyses with regard to knowledge acquisition (Hypothesis 4) or Web site evaluation (Hypothesis 5).

Most correlations between the five dependent variables were significant but weak (see Table 2). Web site evaluation was negatively correlated to the time invested in the task, indicating that evaluations were somewhat higher when less time was invested in the task (or vice versa). The strongest correlation was found between perceived cognitive load and the attitude toward ecogenomics indicating that higher cognitive load was associated with a more negative attitude (or vice versa).

Conclusions and Discussion

In the context of introducing the public to new scientific technologies, the present study tested whether priming and Web site interactivity would affect attitude development and information-processing behaviors among adolescents. The first hypothesis, stating that priming ecogenomics as biotechnology would lead to a more negative attitude whereas priming as ecology would lead to a more positive attitude toward ecogenomics, was not supported. Our expectations were based on the assumption that association with biotechnology or ecology would lead to differential activations of existing attitudes, respectively negative or positive, toward these disciplines. One reason as to why the predicted effects were not found may be that adolescents may not have perceived the information about ecogenomics as personally relevant with the result that attitudes were not affected. Another explanation may be that our assumption that negative (biotechnology) or positive (ecology) ideas would be activated is not correct. Whereas adults may have developed prejudices and/or predispositions about biotechnology and ecology, it may be that adolescents do not have these prior attitudes. Or, perhaps they do have these attitudes, but at least they do not use them when they are introduced to a new emerging technology. It therefore may be that adolescents are more open to process information about new technologies without taking into account prior positive or negative information than adults. In light of previous findings with respect to priming and framing effects, our finding may be interpreted as support for the idea that these factors may not alter perceptions of younger people. The present study suggests that adolescents' attitude toward ecogenomics was generally positive and unaffected by priming.

Web site interactivity levels, however, were found to influence most of adolescents' information-processing behaviors. Our second hypothesis predicted that as Web site interactivity levels increased more time would be spent on processing information about ecogenomics. This hypothesis was partially supported. Higher levels of Web site interactivity were found to increase the time adolescents invested in information retrieval. This finding would be positive if more interactivity (and more time invested in information processing) would have also led to stronger knowledge acquisition (Hypothesis 4), however, this was not the case. Therefore, the finding with regard to spending more time on processing information from interactive Web sites may be interpreted negatively. Although more time was invested in processing information from highly interactive Web sites, the result was that knowledge acquisition did not profit. This finding suggests that interactivity costs time, but that it does not necessarily lead to more knowledge acquisition. Perhaps in contexts in which information is new and complex, an online learning environment should be straightforward and simple, to allow for undemanding browsing and effective knowledge acquisition. Because our expectation that more interactive informational environments would lead to more positive evaluations (Hypothesis 5) was also contradicted, it may be that the "accusation" of Scheufele and Lewenstein (2005) that people are cognitive misers is also a valid observation for adolescents in our study. Our findings suggest that adolescents evaluated the most interactive environment as the least positive. Congruent with the explanation that complex or new information asks for a simple learning environment, it may be that adolescents in the most interactive condition were most negative in their evaluations because there were too many opportunities to "get lost" in the information. As adolescents had more positive evaluations of the Web sites specially developed for this study, in the context of looking for information about new technology, they seem to prefer information readily available instead of information that may be difficult to find.

Overall, our findings about more time invested in tasks, higher perceived cognitive loads, and lower appreciation of the learning environment associated with higher interactivity may be interpreted as a negative influence of interactivity on information processing. Hence, these results are more congruent with findings indicating that too much interactivity may inhibit certain aspects of information processing (see also Vorderer et al., 2001, for example) than findings or expectations suggesting that interactivity may be a solution to many problems (e.g., Kiousis, 2002). So, although the high interactivity of the Internet may be praised for its capabilities to improve cognitive elaboration (e.g., MacGregor & Lou, 2004; Tremayne & Dunwoody, 2001), this is not an inherent feature of the medium. Science Web sites may benefit from simple structured designs that minimize extra cognitive requirements other than that of information processing. Similar to the results found by Macedo-Rouet et al. (2003), the present study suggests that the use of the Internet for dissemination of science information may lead to high levels of perceived cognitive load. And if science communication efforts aim to enhance knowledge acquisition among Web site visitors, any unnecessary increases in cognitive load may be undesirable.

Limitations and Future Research

Of course, this study has limitations as well. First, our measure of knowledge acquisition had a low reliability. However, we tolerated this situation on the basis of the assumption that knowledge acquisition in this context is multidimensional (see also Note 1). If unidimensionality and high internal consistency are criteria for the measurement of knowledge acquisition, different measures should have been developed and used. For that purpose, perhaps separate sets of questions could be employed for subscales pertaining to knowledge about each of the related disciplines such as biotechnology, ecology, and environmental science. Another possibility would be to develop separate sets of questions in subscales varying in the level of difficulty (e.g., easy vs. difficult questions).

Second, the finding that priming effects on attitudes toward new technology may be limited among adolescents cannot be simply generalized to adults. To formulate this difference in a positive way for adolescents: Adults may have a broader knowledge base and better established attitudes toward related scientific issues, which would make them more susceptible to priming than adolescents. In this light, early exposures to information about emerging technology among adolescents may be a fruitful exercise if science communication practitioners aim to prepare future audiences for undesirable media effects.

Third, it is possible that our manipulation of priming was not strong enough. Although our simple manipulation was effective, it may be that stronger manipulations would have resulted in more profound effects on attitude development. Future research could perhaps design conditions in which priming manipulations are directly linked to measures of people's emotions about scientific issues. Whereas our priming manipulation was perhaps close to situations in real life and real information of Web sites, it may be interesting to investigate and compare it with other contexts, such as those that use strong visual channels (e.g., television) or face-to-face communication (e.g., during discussions). Therefore, our study may underestimate the effects of priming on the development of attitudes toward new technologies.

In this light, it may be that our results were influenced by the fact that adolescents have not lived through the agricultural biotechnology controversy to the extent that adults have. As a result, the predispositions toward biotechnology in general that have been measured among adults in the past may not exist among adolescents at this time. Apart from this "generational" issue, there is perhaps also an issue of the "historical context." Early on in the biotechnology controversy there was a focus on agricultural biotechnology with an emphasis on genetically modified food products toward which the public was found to hold negative attitudes. More recently, however, the public may increasingly link biotechnology to medical applications toward which more positive attitudes are held. Additionally, the possible risks and threats of applications of biotechnology that were emphasized in early communications have not occurred yet, so adolescents may perceive the technology as well-established and safe rather than as emergent and uncertain. Finally, it may be that the positive attitudes toward ecogenomics among adolescents were primarily based on the "red" aspects of biotechnology. According to a recent Eurobarometer study (2006), "[t]here is widespread support for medical (red) and industrial (white) biotechnologies, but general opposition to agricultural (green) biotechnologies" (p. 3). Earlier, research on ecogenomics has indeed shown that adolescents tend to focus on these medical applications of ecogenomics (Bos et al., 2009). Future research may want to investigate if differentiation in priming "green," "red," or "white" aspects of new technologies would indeed lead to differential attitudes.

Fourth, our study used a simple distinction between three interactivity levels. Future studies on the effects of Web site interactivity may wish to add or vary interactivity levels to further differentiate which aspects or features of Web sites and/or the Internet are beneficial or inhibiting in science communication contexts. In our study, the strongest differences were found between the high-interactive condition and the low and medium conditions, or, perhaps simpler put, between using the World Wide Web versus using a single Web site. A more elaborate experiment may wish to include a condition where participants are allowed to use more than one interlinked and topic-related Web sites. Also, our Web sites presented pictures but no video materials or games. Adolescents are known to appreciate video materials on Web sites and games may allow them to experience new technology in a simulated environment.

Fifth, the findings of our study may be confined to information-processing tasks in a homework situation. Although participants in our study were not recruited through their schools, it may be that the information-processing task looked much like "regular" homework and that information processing in out-of-school contexts may be affected differently by priming and interactivity. Future research might investigate if there is a difference between how adolescents approach the Internet when used for self-motivated information seeking, as compared with when used for educational and/or school purposes.

Appendix

List of questions for the dependent variables: Attitude toward ecogenomics, Perceived cognitive load, and Web site evaluation.

Attitude Toward Ecogenomics

Do you think working with ecogenomics is . . .

1. worthwhile–worthless?
2. necessary–unnecessary?
3. good–evil?
4. important–unimportant?
5. pleasant–unpleasant?
6. beneficial–harmful?
7. desirable–undesirable?
8. wise–foolish?

(continued)

Appendix (continued)

Perceived Cognitive Load

1. I had difficulty understanding how the information about ecogenomics was structured into a coherent story.
2. Sometimes I felt "lost" when reading the story about ecogenomics.
3. The main points of the story about ecogenomics were clear and coherent.
4. It was clear how all the information about ecogenomics fit into the story as a whole.
5. The information about ecogenomics was so unclear that I found it difficult to understand.
6. The structure and organization of the information about ecogenomics made reading difficult.
7. I had to concentrate very hard to be able to understand the information about ecogenomics.
8. While reading about ecogenomics I immediately understood what it was about.

Web Site Evaluation

1. In general the Web site was to my satisfaction.
2. It was fun to navigate the Web site.
3. The Web site seemed very useful.
4. In general the Web site was boring.
5. The information on the Web site was interesting.
6. When I was done browsing the Web site, I was happy to know of its existence.
7. The Web site is a good example of a Web site I would add to my favorites.
8. I will definitely visit this Web site again.
9. This Web site gave me a sense of being "at home."
10. If this Web site would sell products, I would definitely buy them.

Acknowledgments

The authors would like to thank the anonymous reviewers for their comments on a previous version of this article.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

Funding

This paper is based on work funded by the program "Assessing the living soil," part of the Netherlands Genomics Initiative. For more information, please visit the website www.ecogenomics.nl.

Note

1. The measure "knowledge acquisition" was used despite its low alpha value for two reasons. First, the instrument was not designed to measure a single homogeneous construct but a multidimensional construct. To illustrate, the Dutch Ecogenomics Consortium describes ecogenomics as an area of research that is positioned on the crossroads of molecular biology, biotechnology, ecology, soil sciences and environmental sciences. Second, the measure used only "true" and "false" answer categories. Factor analysis and Cronbach's alpha are most frequently used in the context of Likert-type scales with scaled answering possibilities (e.g., 5- or 7-point scales) but less for dichotomous answering possibilities. In contrast to the other single homogeneous constructs in this study, we had no existing validated scales at hand. Factor analysis showed that the bare minimum to mediocre values was retained (Kaiser–Meyer–Olkin measure of sampling adequacy = .524; Barlett's test of sphericity significance = .000) and (principle component analysis with varimax rotation) that the 11 statements represented at least 5 components. Two statements were assigned to two components (lowest loading .46) but loadings for unique statement–component combinations were all more than .50. All statements were significantly related to one or more other statements ($p < .05$; r ranging from .11 to .24), except for the statement, "All of an organism's DNA codes for genes." In this light, a low Cronbach's alpha was expected and accepted—also because when a measure has other desirable properties, such as meaningful content coverage of some domain, low reliability as established by Cronbach's alpha may not be a major impediment (e.g., Smitt, 1996).

References

Beetlestone, J. G., Johnson, C. H., Quin, M., & White, H. (1998). The science center movement: Contexts, practice, next challenges. *Public Understanding of Science, 7*, 5-26.

Bonfadelli, H., Dahinden, U., & Leonarz, M. (2002). Biotechnology in Switzerland: High on the public agenda, but only moderate support. *Public Understanding of Science, 11*, 113-130.

Bos, M. J. W., Koolstra, C. M., & Willems, J. (2009). Adolescent responses toward a new technology: First associations, information seeking, and affective responses to ecogenomics. *Public Understanding of Science, 18*, 243-253.

Boyle, M. P., Schmierbach, M., Armstrong, C. L., Cho, J., Mccluskey, M., Mcleod, D. M., et al. (2006). Expressive responses to news stories about extremist groups: A framing experiment. *Journal of Communication, 56*, 271-288.

Brewer, P. R., Graf, J., & Willnat, L. (2003). Priming or framing: Influence on attitudes toward foreign countries. *International Communication Gazette, 65*, 493-508.

Bucchi, M., & Neresini, F. (2002). Biotech remains unloved by the more informed: The media may be providing the message—but is anyone heeding the call? *Nature, 416*, 261.

Burgoon, J. K., Bonito, J. A., Ramirez, A., Jr., Dunbar, N. E., Kam, K., & Fischer, J. (2002). Testing the interactivity principle: Effects of mediation, propinquity, and verbal and nonverbal modalities in interpersonal interaction. *Journal of Communication, 52*, 657-677.

Cobb, M. D. (2005). Framing effects on public opinion about nanotechnology. *Science Communication, 27*, 221-239.

Cobb, M. D., & Macoubrie, J. (2004). Public perceptions about nanotechnology: Risks, benefits and trust. *Journal of Nanoparticle Research, 6*, 395-405.

Cocheret de la Monière, E. (2006). De betrokken burger: Een betoog voor meer interactive wetenschapscommunicatie [The engaged citizen: An argument for more interactive science communication]. In B. Broekhans, A. E. Dijkstra, P. Groenewegen, & C. M. Koolstra (Eds.), *Verbeelding van wetenschap, Jaarboek kennissamenleving 2* [Images of sciences, Yearbook knowledge society] (pp. 54-68). Amsterdam: Aksant.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155-159.

Daniel, R. (2004). The soil metagenome: A rich resource for the discovery of novel natural products. *Current Opinion in Biotechnology, 15*, 199-204.

Demain, A. L., & Adrio, J. L. (2008). Contributions of microorganisms to industrial biology. *Molecular Biotechnology, 38*, 41-55.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. New York: Harcourt, Brace Jovanovich.

European Commission. (2006). Europeans and biotechnology ion 2005. Patterns and trends. *Special Eurobarometer 244b*. Retrieved March 20, 2009, from http://ec.europa.eu/public_opinion/archives/ebs/ebs_244b_en.pdf

European Commission. (2008). Attitudes of European citizens toward the environment. *Special Eurobarometer, 295.* Retrieved March 20, 2009, from http://ec.europa.eu/public_opinion/archives/ebs/ebs_295_en.pdf

Eveland, W. P., & Dunwoody, S. (2001). User control and structural isomorphism or disorientation and cognitive load? Learning from the Web versus print. *Communication Research, 28*, 48-78.

Festinger, L. (1957). *A theory of cognitive dissonance.* Stanford, CA: Stanford University Press.

Fiske, S. T., & Taylor, S. E. (1984). *Social cognition.* Reading, MA: Addison-Wesley.

Gaskell, G., Allum, N., Bauer, M., Durant, J., Allansdottir, A., Bonfadelli, H., et al. (2000). Biotechnology and the European public. *Nature Biotechnology, 18*, 935-938. Retrieved June 1, 2009, from http://64.26.159.139/docroot/articles/2000253-A.pdf

Jacobson, S. K., & Marynowski, S. B. (1997). Public attitudes and knowledge about ecosystem management on Department of Defense Land in Florida. *Conservation Biology, 11*, 770-781.

Jensen, J. F. (1998). Interactivity: Tracking a new concept in media and communication studies. *Nordicom Review, 19*, 185-204.

Kalyanaraman, S., & Sundar, S. S. (2006). The psychological appeal of personalized content in Web portals: Does customization affect attitudes and behavior? *Journal of Communication, 56*, 110-132.

Kim, H., & Hirtle, S. C. (1995). Spatial metaphors and disorientation in hypertext browsing. *Behaviour & Information Technology, 14*, 239-250.

Kiousis, S. (2002). Interactivity: A concept explication. *New Media & Society, 4*, 355-383.

Kiousis, S., & McCombs, M. (2004). Agenda-setting effects and attitude strength: Political figures during the 1996 presidential election. *Communication Research, 31*, 36-57.

Koolstra, C. M., & Bos, M. J. W. (2009). The development of an instrument to determine different levels of interactivity. *International Communication Gazette, 71*, 373-391.

Langer, M. L., Gabor, E. M., Liebeton, K., Meurer, G., Niehaus, F., Schulze, R., et al. (2006). Metagenomics: An inexhaustible access to nature's diversity. *Biotechnology Journal, 1*, 815-821.

Lee, C.-J., Scheufele, D. A., & Lewenstein, B. V. (2005). Public attitudes toward emerging technologies: Examining the interactive effects of cognitions and affect on public attitudes toward nanotechnology. *Science Communication, 27*, 240-267.

Lefevre, F., Robe, P., Jarrin, C., Ginolhac, A., Zago, C., Auriol, D., et al. (2008). Drugs from hidden bugs: Their discovery via untapped resources. *Research in Microbiology, 159*, 153-161.

Liu, Y., & Shrum, L. J. (2002). What is interactivity and is it always such a good thing? Implications of definition, person, and situation for the influence of interactivity on advertising effectiveness. *Journal of Advertising, 31*, 53-64.

Macedo-Rouet, M., Rouet, J.-F., Epstein, I., & Fayard, P. (2003). Effects of online reading on popular science comprehension. *Science Communication, 25*, 99-128.

MacGregor, S. K., & Lou, Y. (2004). Web-based learning: How task scaffolding and Web site design support knowledge acquisition. *Journal of Research on Technology in Education, 37*, 161-175.

McMillan, S. J. (2002). Exploring models of interactivity from multiple research traditions: Users, documents, and systems. In L. A. Lievrouw & S. Livingstone (Eds.), *The handbook of new media: Social shaping and consequences of ICTs* (pp. 163-182). Thousand Oaks, CA, Sage.

McMillan, S. J., & Hwang, J.-S. (2002). Measures of perceived interactivity: An exploration of communication, user control, and time in shaping perceptions of interactivity. *Journal of Advertising, 31*, 41-54.

Metzger, M. J., Flanagin, A. J., & Zwarun, L. (2003). College student web use, perceptions of information credibility, and verification behaviour. *Computers & Education, 41*, 271-290.

Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science, 10*, 115-120.

Nahl, D., & Harada, V. H. (2004). Composing Boolean search statements: Self-confidence, concept analysis, search logic, and errors. In M. K. Chelton & C. Cool (Eds.), *Youth information-seeking behavior: Theories, models, and issues* (pp. 119-144). Lanham, MD: Scarecrow Press.

Nisbet, M. C. (2004). The polls-trends: Public opinion about stem cell research and human cloning. *Public Opinion Quarterly, 68*, 131-154.

O'Keefe, D. J. (2007). Post hoc power, observed power, a priori power, retrospective power, prospective power, achieved power: Sorting out appropriate uses of statistical power analyses. *Communication Methods and Measures, 1*, 291-299.

Orbell, S., & Hagger, M. (2006). Temporal framing and the decision to take part in type 2 diabetes screening: Effects of individual differences in consideration of future consequences on persuasion. *Health Psychology, 25*, 537-548.

Petit, R. K. (2004). Soil DNA libraries for anticancer drug discovery. *Cancer Chemotherapy and Pharmacology, 54*, 1-6.

Petty, R. E., & Cacioppo, J. T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change.* New York: Springer Verlag.

Priest, S. H. (2006). The public opinion climate for gene technologies in Canada and the United States: Competing voices, contrasting frames. *Public Understanding of Science, 15*, 55-71.

Rafaeli, S. (1988). Interactivity: From new media to communication. In R. P. Hawkins, J. M. Wiemann, & S. Pingree (Eds.), *Advancing communication science: Merging mass and interpersonal processes* (pp. 110-134). Newbury Park, CA: Sage.

Rafaeli, S., & Sudweeks, F. (1997). Networked interactivity. *Journal of Computer Mediated Communication,* 2. Retrieved October 26, 2006, from http://jcmc.indiana.edu/vol2/issue4/rafaeli.sudweeks.html

Riesenfeld, C. S., Goodman, R. M., & Handelsman, J. (2004). Uncultured soil bacteria are a reservoir of new antibiotic resistance genes. *Environmental Microbiology, 6*, 981-989.

Roelofsen, A., Broerse, J. E. W., De Cock Buning, Tj., & Bunders, J. F. G. (2008). Exploring the future of ecological genomics: Integrating CTA with vision assessment. *Technological Forecasting and Social Change, 75*, 334-355.

Rowe, G., Horlick-Jones, T., Walls, J., & Pidgeon, N. (2005). Difficulties in evaluating public engagement initiatives: Reflections on an evaluation of the UK GM Nation? Public debate about transgenic crops. *Public Understanding of Science, 14*, 331-352.

Scheufele, D. A. (2000). Agenda-setting, priming, and framing revisited: Another look at cognitive effects of political communication. *Mass Communication and Society, 3*, 297-316.

Scheufele, D. A., & Lewenstein, B. V. (2005). The public and nanotechnology: How citizens make sense of emerging Technologies. *Journal of Nanoparticle Research, 7*, 659-667.

Scheufele, D. A., & Tewksbury, D. (2007). Framing, agenda setting, and priming: The evolution of three media effects models. *Journal of Communication, 57*, 9-20.

Schütz, H., & Wiedemann, P. M. (2008). Framing effects on risk perception of nanotechnology. *Public Understanding of Science, 17*, 369-379.

Shanahan, J., Scheufele, D., & Lee, E. (2001). Trends: Attitudes about agricultural biotechnology and genetically modified organisms. *Public Opinion Quarterly, 65*, 267-281.

Sundar, S. S., & Kalyanaraman, S. (2004). Arousal, memory, and impression-formation effects of animation speed in web advertising. *Journal of Advertising, 33*, 7-17.

Smitt, N. (1996). Uses and abuses of coefficient alpha. *Psychological Assessment 8*, 350-353.

Sundar, S. S., Kalyanaraman, S., & Brown, J. (2003). Explicating web site interactivity: Impression formation effects in political campaign sites. *Communication Research, 30*, 30-59.

Tremayne, M., & Dunwoody, S. (2001). Interactivity, information processing, and learning on the World Wide Web. *Science Communication, 23*, 111-134.

Van Woerkum, C., & Van der Auweraert, A. (2004). Wetenschapscommunicatie: Where science meets society [Science communication: Where science meets society]. In C. J. Hamelink, I. van Veen, & J. W. J. T. Willems (Eds.), *Interactieve wetenschapscommunicatie* [Interactive science communication] (pp. 43-53). Bussum, the Netherlands: Couthinho.

Vorderer, P., Knobloch, S., & Schramm, H. (2001). Does entertainment suffer from interactivity? The impact of watching an interactive TV movie on viewers' experience of entertainment. *Media Psychology, 3*, 343-363.

Weigold, M. F., & Treise, D. (2004). Attracting teen surfers to science web sites. *Public Understanding of Science, 13*, 229-248.

Whitmire, E. (2004). The relationship between undergraduates' epistemological beliefs, reflective judgment and their information-seeking behavior. *Information Processing & Management, 40*, 97-111.

Wu, G. (1999). Perceived interactivity and attitude toward website. In M. S. Roberts (Ed.), *Proceedings of the American Academy of Advertising* (pp. 254-262). Gainesville: University of Florida.

Wu, Y-T., & Tsai, C-C. (2005). Information commitments: Evaluative standards and information searching strategies in web-based learning environments. *Journal of Computer Assisted Learning, 21*, 374-385.

Wynne, B. (2005). Reflexing complexity: Post-genomic knowledge and reductionist returns in public science. *Theory, Culture & Society, 22*, 67-94.

Bios

Mark J. W. Bos is a doctoral student at the Department of Science Communication at the Faculty of Earth and Life Sciences, VU University, Amsterdam, Netherlands. His project deals with the introduction of ecogenomics into the public arena and public responses thereupon, focusing specifically on adolescents' information seeking and processing behaviors and their usage of (interactive) media.

Cees M. Koolstra is an associate professor at the Department of Communication Science at the Faculty of Social Sciences, VU University, Amsterdam, Netherlands.

Jaap Willems is a professor in science communication at the Department of Behavioral Sciences, University of Twenty, Netherlands.